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Signed J Evens.

Dated 20 April 2004

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Patents Form 1/77

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THE PATENT OFFICE
21 MAR 2003
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The Patent Office

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP9 1RH

1. Your reference — NPS/P102181GB

2. Patent application number *(The Patent Office will fill in this part)* — 0306547.1

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

The Engineering Business Limited
Broomhaugh House
Riding Mill
Northumberland
NE44 6EG

Patents ADP number *(if you know it)* 7688880001

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — Apparatus for Creating a Local Reduction in Wave Height

5. Name of your agent *(if you have one)* — Harrison Goddard Foote

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Belgrave Hall
Belgrave Street
LEEDS
LS2 8DD
UK

Patents ADP number *(if you know it)* 7631310002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:)* — Yes

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	6
Claim(s)	
Abstract	
Drawing(s)	2

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 21st March 2003

12. Name and daytime telephone number of person to contact in the United Kingdom: Nigel P Sanderson 0113 233 0100

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

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Apparatus for creating a local reduction in wave height.

The installation and maintenance of offshore structures such as wind turbines and wave energy extraction systems are effected by the ocean waves at the work site causing floating vessels to move. The time taken to wait for calm conditions to permit safe operations is expensive and damaging to the productivity of, for example, installing large numbers of machines, which constitute an offshore wind or wave power station. These vessel motions can also cause dangerous conditions to develop during lifting, assembly and access operations. It is also increasingly recognised that prolonged work at offshore locations can have a damaging effect on wildlife at the work site which is not used to human presence and activity.

This has lead offshore wind farm developers and others to propose large jack-up vessels to remove or avoid the effects of wave motions on vessels required to work at a n offshore work site by jacking the vessel partially up or lifting it clear of the sea surface. Several wave energy projects have been delayed by wave action in the construction / installation phases.

This present invention seeks to produce a temporary floating wave energy absorber which, when deployed in front of the vessel undertaking works such as installation or maintenance, provides a reduction in the wave height in the area of the work vessel. This so-called wave shadow of calmer water permits the marine operations to be conducted by a much cheaper floating vessel in a safer environment without the costs associated with waiting for calm offshore conditions.

Prior Art

US Patent No 2,388,171 – dated 30 Oct 1945, describes a series of floating blocks to provide wave protection. The blocks are anchored to the sea bed. Protection is provided by a combination of drag and reflection.

US Patent No 5,702,203 – dated 30 Dec 1997, describes a floating "V" shaped breakwater which provides protection by deflecting the incoming waves.

US Patent No 3,969,901 – dated 20 July 1976 describes a floating breakwater which acts to reflect the wave energy.

US Patent No 3,952,521 – dated 27 April 1976, describes a portable floating wave tripper which acts to cut the wave into sections disturbing the flow

US Patent No 4,468,151 – dated 28 Aug 1984, describes a fixed structure for damping sea waves as they approach a sea wall.

US Patent No 4,027,486 – dated 7 June 1977, describes a floating breakwater which acts to reflect the wave energy.

US Patent Application No US 2002/0085883A1 dated 4 July 2002, describes a floating breakwater which acts to reflect the wave energy.

Many of the prior art designs rely on reflection of the wave energy as the waves impact on structure. In large waves and storm conditions the amount of energy in the wave can cause damage to the structure, or can require the design to be prohibitively expensive. Several of the designs rely on multiple anchors to hold the breakwater in position which is inconvenient and potentially time consuming during installation. Some prior art designs utilise large elements which need to be fitted together to provide the breakwater. This can take a significant amount of time, making such systems unsuitable for temporary installations. Commonly the prior art uses structural mass to provide reaction to wave-imposed forces which in turn requires the breakwater to be heavy and thus cumbersome to transport and store.

The invention seeks to provide a method and apparatus for the deployment at sea of a structure which acts to reduce the wave height by inducing viscous drag between the structure and the circulating water molecules as the wave travels along. The apparatus is desirably collapsible and may be either buoyant, semi-buoyant or non-buoyant and suspended at set depth in the water column. The apparatus broadly takes the form of one or more mat-like structures (hereinafter "mats") and the width of the

or each mat is typically deployed at 90 degrees to the predominant wave direction. That is, its length (i.e. major dimension) is disposed generally parallel to the predominant wave direction. The mat(s) is (are) deployed off a suitable structure to ensure the waves pass under the leading edge. In preferred arrangements, the drag induced by the movement of the waves trails the mat out in the direction of wave movement. Once the wave starts to pass under the mat viscous drag between submerged elements of the mat progressively removes the potential and kinetic energy in the wave, so reducing the wave height.

It is anticipated that a typical mat may be 50 to 100m long and work over a width of wave front of about 100m. The wave shadow behind the mat is estimated to be 100m long before diffraction will cause the wave front to re-establish.

The apparatus of the invention removes energy progressively and in a self limiting way, limiting the storm loading and providing a more cost effective design. The apparatus of the invention further makes advantageous use of drag from the waves to hold it in the correct orientation. This makes installation quicker and more suitable for short term and temporary operations. The mat forming the apparatus of the invention can be stored on suitably arranged rotary storage reels. Once in location the mat is unwound onto the sea surface. When in storage on the reels the mat volume is minimised by the structure collapsing. In this way temporary use of the apparatus of the invention at a given location is both quick and cost effective.

In a preferred arrangement, during operation the shape of the mat can be maintained using water pressure in closed structures, e.g. sealed flexible structures, across and along the length of each mat. This encapsulated water also provides mass to the mat to help maintain shape and correct operation of the drag which is induced. This mass can be removed during transport and storage by draining out the water.

Pumped water may be jetted out from the mat into the wave to further disrupt the wave circulation and reduce the wave height. Shapes may be added under the mat

structure to increase the surface area and complicate the flow path for the water molecules in the wave. This may include but not be limited to:-

a multiplicity of self inflating drogue anchors;
a multiplicity of pumped water inflated shapes to increase drag and flow path length under the mat;
surface coatings on the mat and the inflated shapes to provide increased drag action. This could be bristles, shapes or fronds.

It is possible that the apparatus could be deployed in 20 or 30m wide mat strips to reduce the weight of each section. The drag action of the wave as it passes away from the deployment / anchoring structure will keep the mat spread out over the surface of the water.

The uses of the invention may include but not be limited to:-

short term protection from waves for shore, near shore and offshore work where waves and vessel motions limit operations;
temporary harbour for loading and unloading equipment at sea;
short term protection for beach landings of personnel and/or equipment;
offshore wind turbine installation, maintenance and decommissioning;
wave power equipment installation, maintenance and decommissioning.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will be made, by way of example only, to the following drawings in which:

Figure 1 illustrates schematically the deployment of an apparatus according to the invention from a vessel so providing a "wave shadow" for a work vessel;

Figure 2 shows a the deployment vessel and apparatus according to the invention on a larger scale;

Figure 3 shows schematically a series of mat structures according to the invention deployed from a vessel;

Figure 4 shows schematically in detail the construction of one embodiment of the apparatus of the invention; and

Figure 5 shows a schematic view of the underside of one embodiment of the apparatus of the invention.

Referring now to the drawings, the mat-like structure (10) of the invention is initially retained on a storage reel (12) on a deployment vessel (14) or other suitable structure. The mat structure (10) is deployed in a chosen location to provide in use a wave shadow (i.e. an area of calmer water where the wave height is reduced) for a work vessel (16). The mat structure (10) is deployed in this embodiment at the water surface. As can be seen from Figure 3, the apparatus of the invention may comprise a plurality of adjacently located mat structures (10a-10d) deployed from a barge (18) to provide a desired width for the wave shadow area.

Figure 4 shows an embodiment of the apparatus of the invention which comprises a series of floatation elements (20) which may take the form of individual rigid or semi-rigid sections or may alternatively comprise a substantially continuous sheet of flexible floatation material. Longitudinal water pipes (22) act to provide structural shape and mass to the apparatus, as do transverse water pipes (24). Of course, these pipes (22, 24) could be filled with a fluid other than water, but water is more convenient. Disposed under the floatation elements (20) are shaped elements (26) which may be self-inflated or pressurised (allowing them to be collapsed when in storage) and which act to increase the water flow path (i.e. its length and/or complexity) and so increase drag on the apparatus. Flexible strain members (28) are

provided to carry drag forces from the collapsible underwater shapes (26) into strain members in the mat structure (20) and this to the deployment vessel (14).

Figure 5 shows an example of an underside structure of a mat (10) according to the invention including a plurality of shaped elements (26). The surfaces of these shapes are preferably covered with structures which act to increase drag of passing water molecules. These structures may, for example, be bristles or fronds. Alternatively, the shaped elements (26) may be absent with the underside of the mat (10) directly covered (at least partially) with drag-increasing bristles, fronds or the like. Flexible stain members (28) are disposed beneath the shaped elements (26) in a reticulate structure.

In other embodiments of the invention the shaped elements (26) may be replaced, at least in part, with a plurality of layers of reticulate material such as fishing net suspended below the floatation elements (20) so that drag is provided by water passing in and out of the net weave.

In another alternative embodiment the shaped elements (26) may be replaced, at least in part, with a series of drogue anchors constructed from a flexible material. As a wave passes a drogue anchor, the water molecules flood the parachute of the anchor causing it to open out and so providing increased drag and an increased water molecule flow path.

Figure 1

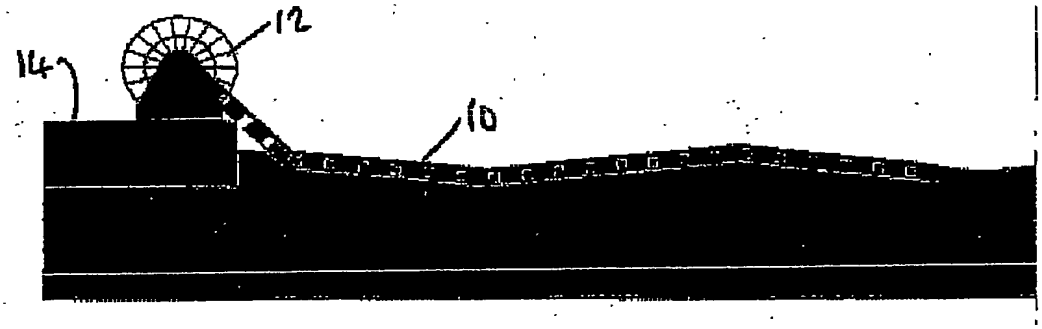

Figure 2

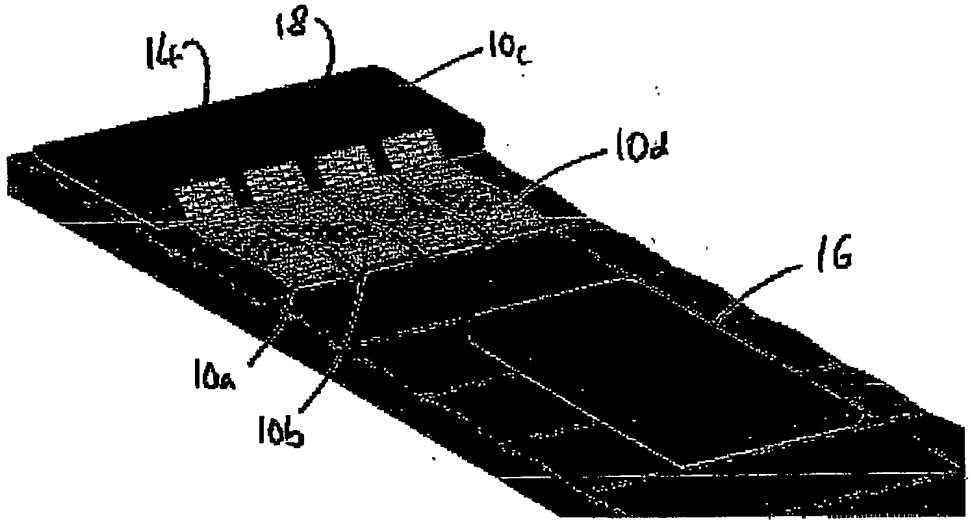

Figure 3

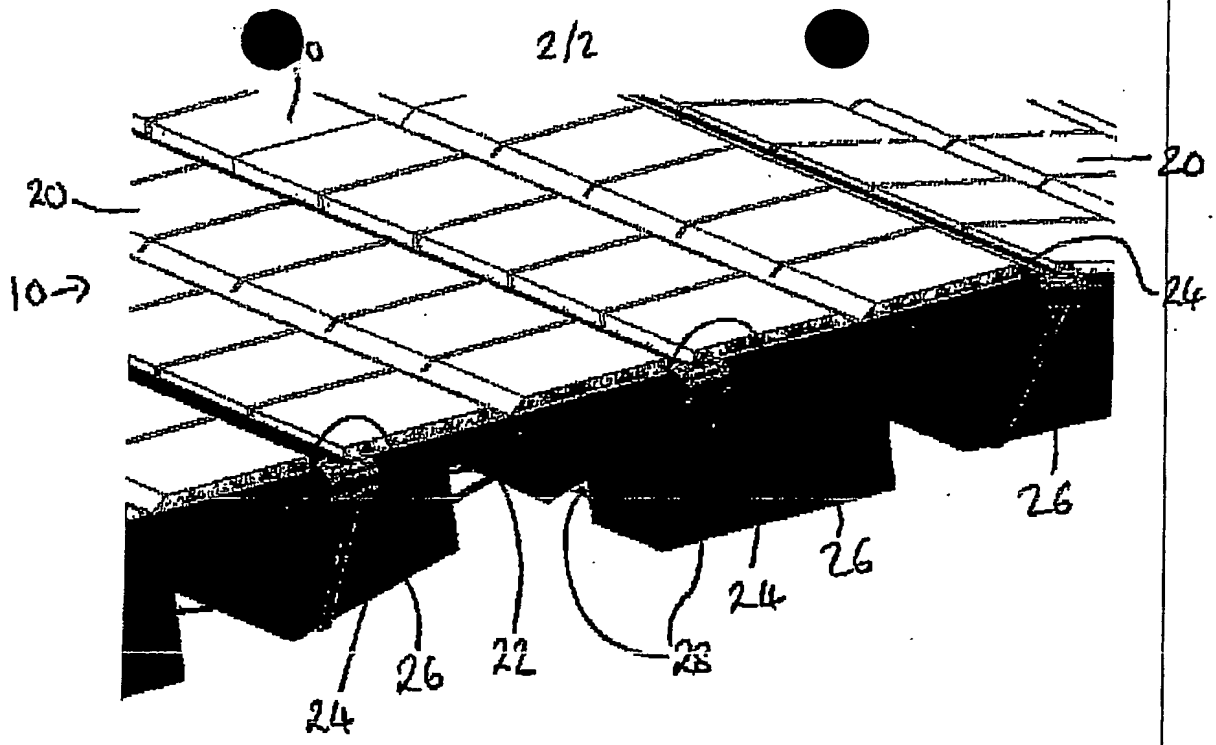

Figure 4

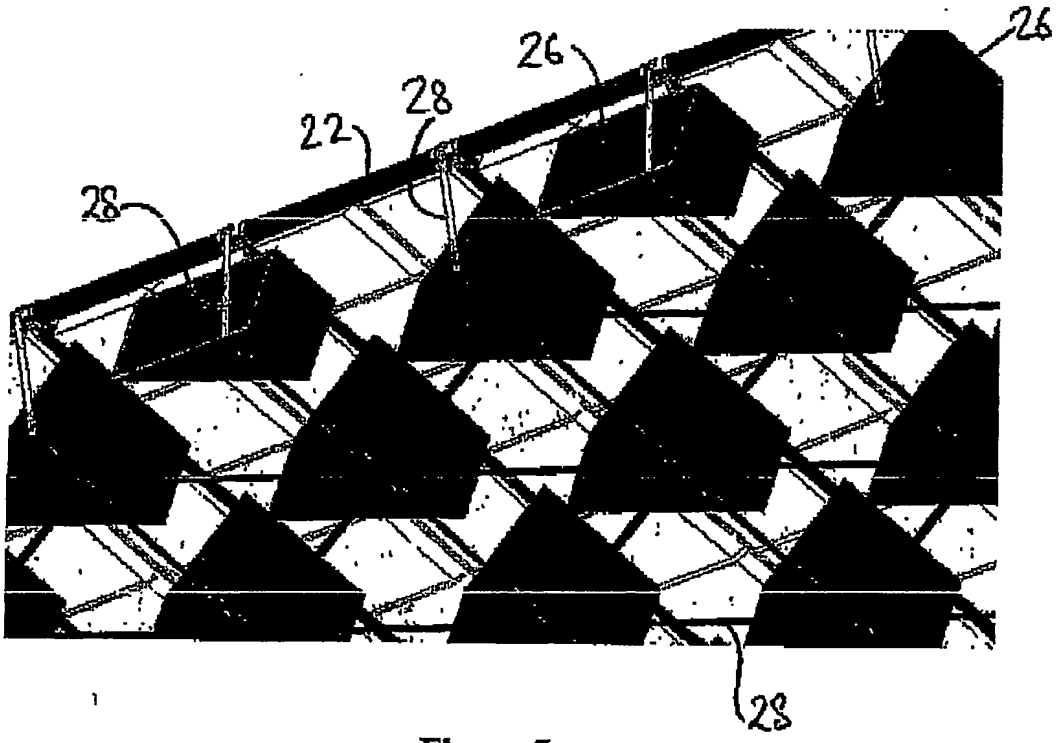

Figure 5